The Structural Barrier to Transition:
A Note on Input-Output Table of Centrally Planned Economies

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1. Introduction.

This note begins an exploration of one of the key legacies of the Soviet economic system, the physical structure of production and economic interaction, and its impact on the transition to a market-based system. It addresses some reasons for the size of the "shock" to the economy subsequent to the liberalization of prices, including the apparent disappearance of vast amounts of industrial output and an inflation driven by more than just monetary factors.

Price liberalization introduced a fundamental change in the valuation system for the economy which, together with the new freedoms from 'market liberalization,' generated massive real effects independent of monetary policy. It involved far more than an accounting change, or correcting for statistical biases, both due to the massive structural deformations built into the economy by over 60 years of investment and development decisions innocent of economic evaluation, and due to the systematic, arbitrary mismeasurement of economic activity and capacities. Thus a structure of production — location, capital, employment, materials and energy use, etc. — was created, without any regard for economic opportunity costs, in an environment free of economic valuation and only subject to

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consistency in arbitrarily measured accounting units. This legacy of the Soviet system constitutes a structure of capital and economic activity that is fundamentally non-viable in an environment determined by market valuation, and hence requires massive transformation at its very roots.

This legacy lies at the root of the apparent paradox of transition: a seemingly massive collapse in industrial output that is coupled with high inflation, particularly of industrial prices. Here I want to suggest that this "inflationary deindustrialization" is a necessary part of an essential structural transformation, and is only aggravated by policy measures aimed at preserving capacities and maintaining production. The heart of the problem lies in the illusion of capacity, measured in terms of final output, and of productivity as measured, after adjustment, by economic statistics and, in particular, in Input-Output tables. Below I will argue, through examples, that much of the drop in output is just the revelation of economic inefficiency, i.e. much of the measured output was illusory, while much of the price rise has been an attempt to cover immediate economic costs that were ignored in the prior system. The need to account for these costs reveals the non-viability of much existing capacity, its inherent "value destroying" nature.[1]

Indeed, when producers are forced to cover the true market costs of material inputs, they find that their structure of production, their combination of inputs and factors, is unable to generate enough surplus to cover basic factor costs. Thus payments arrears arise, coupled with further attempts to raise own prices, while output contracts. This can be seen in a typical (stylized) dynamic of the Russian transition: free prices lead to a rise in material input costs, raising production costs that feed further increases in input costs throughout the chain of production. Demand, however, limits the rise in output prices, hitting the ability to pay wages and maintain capital, leading to wage, tax and payment arrears, the misuse of amortization funds, and the shrinkage of capacity, while still tying up a proportionate share of intermediate product flows. Central interventions, through loans, subsidies or state orders to prevent shutdowns and maintain capacities, only compound the damage. For they maintain fundamentally irrational capacities and a fundamentally irrational structure of interaction, slowing the structural transfor-

[1]Throughout the paper I use the term "value destroying" in the net sense: the market value of the output produced is insufficient to cover the full costs of production, including the opportunity cost of the factors of land, labor and capital. The stronger sense of "gross value destroying," i.e. the value of output is insufficient to cover the cost of even just material inputs, is rare, but not unheard of, in the post-Soviet economies.

mation and freezing in place wasteful materials and factor use, as well as spurring inflation through monetary emission.

It can be argued that this unfortunate dynamic is to a large extent a consequence of the irrational structure of production hidden in apparently consistent (adjusted) Input-Output (I-O) matrices and economic statistics. The purpose of this note is to explore the plausibility of that line of argument by analysing the kinds of distortions that were hidden in those matrices.

2. Soviet Pricing and I–O Matrices.

The four-quadrant input-output matrix, in producers' prices, has been long considered a useful tool for understanding the structure of the Soviet and other centrally planned economies (CPE's) and the possibilities for near term changes in the level and structure of economic activity.[2] As such it should also be a useful tool for understanding the structural issues and difficulties in transition from a centrally planned to a largely market economy. Use of these tables must, however, take account of the peculiarities of both accounting practice and measurement of the basic economic flows in these countries, particularly in the Soviet Union.[3] Since the raw data are always in the form of index numbers, they depend critically on the prices used to form those index numbers. The issue is deeper than just considering the impact of indirect taxes and other surcharges/discounts/subsidies applied on various transactions; it resides in the fundamental principles of price formation and the resulting structure of consistent (e.g. producers' or 'adjusted factor cost') prices used to measure and value transactions.[4]

In the Soviet economic system, the only relation that prices had to economic costs and/or scarcities was through a general, average, requirement that prices "cover costs" in most cases, where 'costs' were measured expenditures on materials, labor, amortization, etc., and those were in turn valued in similarly formed prices. This created a consistency of 'circularity-in-definition' that lacked any systematic tie to underlying economic values ("opportunity costs") or scarcities.

[2] Some classical references are Levine (1962), Hardt, et. al. (1967), Treml and Hardt (1972), and Treml, et al. (1972).

[3] See Bornstein (1970, 1987) and Treml, et al., (1972) for discussion of some pricing peculiarities. Other problems created for the measurement and evaluation of economic activity by Soviet pricing practices are discussed in Rosefielde and Pfouts (1995).

[4] For example, Treml (1989) presents the 1988 Soviet I-O table in producers' prices, while Rosefielde (1975) reconstructs the 1966 table in terms of adjusted factor costs.

Among other distortions, basic factors were seriously undervalued (land was free, and capital-in-place virtually so), raw materials and natural resources were undervalued, highly processed goods — in particular investment products and services — were seriously overvalued, and inputs and consumables received differentiated valuations, depending on the 'priority' (desirability in eyes of planners) of the use to which it was being put. This means that the 'physical' quantities and 'valuation units' behind different entries in the table are not generally comparable, even after tax and subsidy adjustments and "adjusted factor cost" manipulations, and treating them as such creates a distorted image of the structure and functioning of those economies. For example, it can create the illusion that 'materials-intensity' of production in centrally planned economies does not differ significantly, outside perhaps the energy sector, from that of market-type economies (see, for example, Drábek (1988), arguing the lack of significant difference between Austria and Hungary, and the study of Gomulka and Rostowski (1988)). Indeed, the distortions in the principles of economic valuation use in CPE's systematically hide tremendous waste, exaggerating both net outputs and net income (economic value) produced, while understating the productivity of that most seriously mismeasured factor of production, capital. Thus, the size of the apparent collapse in industrial production is seriously exaggerated, even if one ignors new economic activity generated in the wake of the reforms.

Below we illustrate this problem with simple examples, and then return to some of the implications of this for the economics of transition from 'socialism' to 'markets.' In the next section we present the analysis of a simple 4-quadrant I–O matrix, illustrating how inefficiency and the exaggeration of net output can be hidden in one. In the fourth section we study the circularity of I–O pricing, and how this is consistent with the hidden inefficiency illustrated in Section 3. The fifth section returns to the discussion of some implications of these results for the study of transition processes in these economies, particularly with regard to the apparent inevitability of "deindustrialization."

3. I–O Inefficiency: An Example.

Consider a simple economy in which all activity is aggregated into two producing sectors, RM – 'raw materials,' and MG – 'manufactured goods.' Final demand is composed of C – 'consumption,' I – 'investment,' and G – other 'government' expenditures including military. Net national income is accounted for as either 'wages' or 'profits.' Such an economy might be described by the following Input-

Output matrix in nominal aggregate 'values,' where the rows reflect the allocation of the output/value of {RM, MG, W, Π} and the columns — the full costs of producing that output/value in each of the sectors/activities {RM, MG, C, I, G}.

$$B = \begin{array}{c} \\ \text{RM} \\ \text{MG} \\ \text{W} \\ \Pi \end{array} \begin{array}{c} \begin{array}{ccccc} \text{RM} & \text{MG} & \text{C} & \text{I} & \text{G} \end{array} \\ \left[\begin{array}{ccccc} 60 & 40 & 10 & 5 & 5 \\ 30 & 50 & 10 & 10 & 5 \\ 15 & 10 & 20 & 5 & 0 \\ 10 & 10 & 0 & 10 & 10 \end{array}\right] \end{array} \equiv \begin{bmatrix} X & Y \\ V & G \end{bmatrix}. \tag{3.1}$$

As usual, the matrix $X = \begin{bmatrix} 60 & 40 \\ 30 & 50 \end{bmatrix}$ represents the apparent value of intersectoral product flows (intermediate inputs), $Y = \begin{bmatrix} 10 & 5 & 5 \\ 10 & 10 & 5 \end{bmatrix}$ — the final demand uses, $V = \begin{bmatrix} 15 & 10 \\ 10 & 10 \end{bmatrix}$ the 'value added' in the sectors, and $G = \begin{bmatrix} 20 & 5 & 0 \\ 0 & 10 & 10 \end{bmatrix}$ — the reallocation of value to uses making this accounting consistent.[5]

The hypothesis that we are investigating is that these apparently consistent flows hide a much less efficient economy, in terms of materials use, due to systematic distortions in pricing. Indeed, the underpricing of intermediate inputs and the overpricing of final demand products could produce B from the following adjusted (to accurately reflect true economic activity) matrix with uniform 'opportunity cost' pricing:[6]

$$C = \begin{array}{c} \\ \text{RM} \\ \text{MG} \\ \text{W} \\ \Pi \end{array} \begin{array}{c} \begin{array}{ccccc} \text{RM} & \text{MG} & \text{C} & \text{I} & \text{G} \end{array} \\ \left[\begin{array}{ccccc} 65 & 44 & 5 & 3 & 3 \\ 34 & 56 & 5 & 6 & 4 \\ 6 & 5 & 10 & 1 & 0 \\ 10 & 5 & 0 & 9 & 6 \end{array}\right] \end{array} . \tag{3.2}$$

This shows a loss in real incomes due to the greater use of products/materials within the production sector, reducing the amount actually available for end-

[5] For a concise description of, and further references on, four-quadrant I–O tables, and a discussion of the 1988 Soviet I–O table, see Treml (1989).

[6] Other principles of adjustment are possible. For example, the prices of final goods could be taken as basic, with all other valuations inflated to that level (with some structural adjustment of relative prices) maintaining total value added while inflating the value of gross as well as intermediate output. See the next note.

uses. Notice that in both cases the gross output is assumed to be the same; $x = \begin{bmatrix} 120 \\ 105 \end{bmatrix}$.[7]

The losses can be seen in the difference matrix

$$D = C - B = \begin{bmatrix} 5 & 4 & -5 & -2 & -2 \\ 4 & 6 & -5 & -4 & -1 \\ -9 & -5 & -10 & -4 & 0 \\ 0 & -5 & 0 & -1 & -4 \end{bmatrix} \tag{3.3}$$

showing the absolute shift in National Income and its allocation resulting from proper evaluation of product/resource flows. The apparent I-O coefficients,

$$A = \begin{bmatrix} X_{1,1}/x_{1,1} & X_{1,2}/x_{2,1} \\ X_{2,1}/x_{1,1} & X_{2,2}/x_{2,1} \end{bmatrix} = \begin{bmatrix} \frac{1}{2} & \frac{8}{21} \\ \frac{1}{4} & \frac{10}{21} \end{bmatrix} \tag{3.4}$$

are significantly smaller than the actual

$$\Lambda = \begin{bmatrix} C_{1,1}/x_{1,1} & C_{1,2}/x_{2,1} \\ C_{2,1}/x_{1,1} & C_{2,2}/x_{2,1} \end{bmatrix} = \Lambda = \begin{bmatrix} \frac{13}{24} & \frac{44}{105} \\ \frac{17}{60} & \frac{8}{15} \end{bmatrix}, \tag{3.5}$$

with the difference being

$$\Delta = \Lambda - A = \begin{bmatrix} \frac{1}{24} & \frac{4}{105} \\ \frac{1}{30} & \frac{2}{35} \end{bmatrix}. \tag{3.6}$$

Note that the net output produced with technology Λ, z, is much less than $y = \begin{bmatrix} 20 \\ 25 \end{bmatrix}$; $z = x - (\Lambda x) = \begin{bmatrix} 11 \\ 15 \end{bmatrix}$. This difference illustrates the exaggeration of net output (national income) generated by the relative underpricing (resp. overpricing) of intermediate product flows (resp. final output).

This phenomenon is quite general and is in no way dependent on our particular choice of dimensions and/or numbers. To see this, let $q \in \mathbf{R}^n, Q \in \mathbf{R}^{n \times n}, z \in \mathbf{R}^n$ represent the "true" physical indices of gross output, intersectoral flows, and total final use of the product of n producing sectors, and let Ξ be the $(n \times n)$-matrix

[7] This need not be the case; indeed one might expect total output to also be exaggerated due to the incentives in the Soviet system. It is also possible that some of the extra intermediate product use is of unmeasured/unreported output, so there is a counterveiling tendency for total output to be understated. In any case it makes no difference in this example as linearity gives us one degree of freedom.

of multipliers reflecting the input pricing distortions that, element by element, generate the observed intersectoral product flows, and Ω, Θ be the n-vectors generating observed gross and net output respectively. Then the I–O system, as measured in national income accounts, $x = X \cdot e + y$, $e \equiv (1, \ldots, 1)$, is generated as follows ($\times$ — indicates element-by-element multiplication):

$x = \Omega \times q$	$x_i = \omega_i q_i$
$X = \Xi \times Q$	$x_{ij} = \xi_{ij} q_{ij}$
$y = \Theta \times z$	$y_i = \theta_i z_i$

where the multipliers reflect the relation between a "true index" at the given level of aggregation and the "physical accounting" index in national statistics. In our example, $\omega_i = 1, \forall i, \quad \Xi = \begin{bmatrix} 12/13 & 10/11 \\ 15/17 & 25/28 \end{bmatrix} \equiv \begin{bmatrix} .92308 & .90909 \\ .88235 & .89286 \end{bmatrix}$, and $\Theta = \begin{bmatrix} 20/11 \\ 5/3 \end{bmatrix} \equiv \begin{bmatrix} 1.8182 \\ 1.6667 \end{bmatrix}$, showing the pricing-induced proportionate distortions in the measurement of 'physical' indices.

Note that in the Soviet case, as illustrated in this numerical example, there was no reason for $\xi_{ij} = \xi i$, or for $\xi_{ij} = \omega_i$ or θ_i, $\forall j$, as prices of given commodities varied to different uses and users for priority and other policy reasons. Indeed, the various components of Y had different prices, so that each θ_i might be a vector $(\theta_{ij})^m_{i,j=1}$ for the m different end-uses accounted for in the table, and $y_{ij} = \theta_{ij} z_{ij}$. Thus, although aggregate consistency of measured materials flows was forced by the intersectoral balance methodology, there was little necessary relationship between those flows and what actually occurred in the economy. This is true despite the ability to find a consistent system of 'Leontief' prices fully covering the "costs" of production of the apparent output flows, including the required "surplus" for factor payments, as will be illustrated in the next section.

4. Pricing Consistency and Measurement.

Here we illustrate the existence of sectoral input-output price indices consistent with sectoral 'cost-covering' and the preexisting distorted micro-level prices. Any such prices are determined by both intermediate input requirements and by the required 'value added' to support the factors necessary for production. Thus these prices are relative to the 'numeraire' used in defining the "value added" in each producing sector. These prices have no necessary relationship to the aggregation/valuation weights ("prices") used to generate the measurements in the I–O matrix cells.

In our illustrative example, the apparent value-added per unit gross output in each sector is given by

$$v = \begin{bmatrix} 25/120 & 20/105 \end{bmatrix} \equiv \begin{bmatrix} .20833 & .19048 \end{bmatrix},$$

whereas the true surplus (net value) created by production is

$$\nu = \begin{bmatrix} 16/120 & 10/105 \end{bmatrix} \equiv \begin{bmatrix} .13333 & 9.5238 \times 10^{-2} \end{bmatrix},$$

indicating a proportional distortion of $\varsigma = \begin{bmatrix} 25/16 & 2 \end{bmatrix} \equiv \begin{bmatrix} 1.5625 & 2.0 \end{bmatrix}$. This value added covers all costs beyond those on intermediate purchases from other producers. Hence we might write, for example, v (or ν) $= w\ell + rk + \pi$, where (w, r) are the unit costs of factors, (ℓ, k) are the appropriate unit-input coefficients for the factors (L, K), and π is the surplus covering all other residual (opportunity) costs. These also reflect the per-unit surplus produced in each sector that is consistent with fully financing the purchase, at the relevant prices, of the net output produced. Hence v is exaggerated by the need to finance fictitious output.

Thus 'cost-covering' sectoral prices that generate the apparently required surplus are given by:

$$c = v(I - A)^{-1} = \begin{bmatrix} .94047 & 1.0476 \end{bmatrix}, \tag{4.1}$$

while actual cost-covering prices are given by:

$$p = \nu(I - \Lambda)^{-1} = \begin{bmatrix} .93743 & 1.0459 \end{bmatrix}. \tag{4.2}$$

If, however, the apparent prices, c, are used to evaluate the full materials usage, then the remaining surplus per unit of output is only

$$c(I - \Lambda) = \begin{bmatrix} .13422 & 9.4788 \times 10^{-2} \end{bmatrix} \ll v = \begin{bmatrix} .20833 & .19048 \end{bmatrix},$$

while at the true cost-covering prices the per unit generated surplus is

$$p(I - \Lambda) = \begin{bmatrix} .13333 & 9.5238 \times 10^{-2} \end{bmatrix} = \nu.$$

Further, if the true prices p were used to evaluate the surplus with the understated I–O coefficients then the apparent surplus becomes: $p(I - A) = \begin{bmatrix} .20725 & .19071 \end{bmatrix}$.

Notice that this is very close (within 'statistical error') to $v = \begin{bmatrix} .20833 & .19048 \end{bmatrix}$ as $p \approx c$, supporting the illusion — due to the fact that the apparent I–O table, B, is consistent — that the apparent quantities reflect the true production structure of the economy.

It is worth noting that, since total output is assumed the same, the per-unit surplus needed to finance the much smaller real net output will be less than that needed with relatively inflated final good prices. Therefore the "cost-covering" price systems, c and p, need not differ greatly in level, despite possible large structural differences, as net output and unit surplus move in the same direction: $(y, v) > (z, \nu)$. This is easily seen from the algebra:

Apparent Technology	Actual Technology
$x = (I - A)^{-1}y$	$x = (I - \Lambda)^{-1}z$
$c = v(I - A)^{-1}$	$p = \nu(I - \Lambda)^{-1}$
$v \cdot x = c \cdot y$	$\nu \cdot x = p \cdot z$

Thus hidden distortions are only reflected in the sectoral structure of prices.

Of course, if each sector's output were truly homogeneous then the conscientious use of uniform "producers' prices" by the statistical authorities would eliminate the hidden distortions modeled here; all uses would be charged the same producers' prices. The fact, however, that physically different products (goods and services) of a given sector are used both by different sectors and for different types of final demand means that the uniform use of producers' prices at the micro level can yield precisely the distortions pointed to here.[8] All that is required is that there be some differences in the subsets of particular products of a sector allocated to differing uses for an index formed of producers' prices to undervalue intermediate input uses (types of products) and over value final demand uses (types of products), even after all explicit taxes/subsidies have been accounted for.

This can be clearly seen in our example where the subset of RM products used as inputs into the RM sector have a price index that is 92.308% of the sectoral index, that used in the MG sector — 90.909% of the index, and the subset used by final demand — 181.82%. Similarly, the distortion of the MG price index

[8]For example, automotive products use as inputs into agriculture are different from those in mining or textiles or metalworking, which again differ from those used in personal consumption and from those used in investment/construction activities. The same is true of the nomenclature of virtually every sector of production, with the possible partial exception of nearly homogeneous raw materials and energy.

from specific pricing of the assortment used in different sectors (RM,MG,Y) is: $(88.235\%, 89.286\%, 166.67\%)$. Thus the consistent use of producers' prices fails to address the issue of price distortions arbitrarily built into the price system when agents need not respond to market pressure; such prices can hide the true structure of the economy even when the aggregate value I–O matrix is fully consistent. This creates serious problems, both economic and political, for the process of transition from a command economy where such arbitrary valuations can persist to a market economy where signals and perceptions of relative economic valuations drive most economic activity.

5. Implications for Transition.

The process of liberalization and economic reform removes, if sometimes only gradually, the constraints on economic behavior that maintained the structure of activity reflected in full, four-quadrant I–O tables of command economies. Decentralization and the allocation of ultimate responsibility for economic outcomes to individual economic units provides both the incentives and the capability for those units to respond to, and alter, the relative valuations built into the structure of economic activity. They are, however, at least initially constrained by the inherited structure of production, the existing, largely technologically determined, configuration of capital, labor, and materials input use, within which they must strive to maximize value (survive).

The first impact of this freedom is typically seen in the move to raise prices to cover full material costs, as well as to cover the dramatically increased costs of labor, which previously were held down by subsidizing basic consumer necessities and eliminating competitive pressure from Soviet 'labor markets'. Of course, at those increased prices demand for many products, now not supported by plan requirements, falls dramatically. To the extent that shipment is made without payment, a liquidity and arrears crisis arises. In addition, amortization funding collapses, as does maintenance of the already seriously underfunded capital stock together with any real plans for its replacement/updating. This freezes the irrational and wasteful structure of production, labor, and capital into place. Thus the existing structure of production generates a self-feeding collapse of output, a cycle of "deindustrialization," as the result of liberalization. Government efforts to slow or halt the collapse by providing financial support for existing activities run the risk of merely maintaining the inherited wasteful, value-destroying structure of production and factor employment, one unrelated to final use-value or relative scarcity, that lies at the root of many of the economic problems of the transition.

At the level of our example, the problem can be seen by comparing the initial structure of production, (A, v) or (Λ, ν), given above with a plausible market-driven structure of production. Suppose that, at the two sector level of aggregation, competitive market technology is given by

$$T = \begin{bmatrix} \frac{5}{12} & \frac{1}{3} \\ \frac{1}{5} & \frac{2}{5} \end{bmatrix}, \quad s = \begin{bmatrix} .18 & .15 \end{bmatrix} \tag{5.1}$$

where T gives material requirements and $s = w\ell + rk$ (for simplicity here and in the subsequent examples) gives the necessary value added to support efficient factor use in each of the sectors. Again let desired aggregate net output be $y = \begin{bmatrix} 20 \\ 25 \end{bmatrix}$. Then, assuming that these quantities are measured and aggregated in consistent equilibrium (market-clearing) prices, we can calculate the gross output, x, and fully cost-covering sectoral price indices, P, as follows:

$$x_m = (I - T)^{-1} y = \begin{bmatrix} 71.765 \\ 65.588 \end{bmatrix},$$

$$P = s(I - T)^{-1} = \begin{bmatrix} .48706 & .52059 \end{bmatrix}. \tag{5.2}$$

Notice that both gross output and price levels are much lower as greater efficiency requires both lower factor use and fewer intermediate inputs to support the same level of final demand. Further, note that the same gross output as before, assuming sufficient availability of basic factors, produces a far greater net output (GDP) than before:

$$y_m = (I - T)x = \begin{bmatrix} 35 \\ 39 \end{bmatrix}.$$

A sizable part of the problem of transition consists of restructuring from the (Λ, ν) technology, supported by intersectoral relative prices p, to the sustainable market structure (T, s) with supporting intersectoral valuations P. The problem is aggravated when the initial situation is taken to be the illusory (A, v), and even more so when the relative prices P are rapidly imposed from the outside by competitive market pressure (eg. free trade possibilities). When P is imposed on the initial technological structure, the net value added becomes:

$$\begin{aligned} P(I - \Lambda) &= \begin{bmatrix} .075735 & .03884 \end{bmatrix} \ll \nu; \\ P(I - A) &= \begin{bmatrix} .11338 & .087143 \end{bmatrix} \ll v; \end{aligned} \tag{5.3}$$

which is substantially less than required to support factor inputs in any of the technological structures, even that of the future market structure, where $P(I-T) = \begin{bmatrix} .18 & .15 \end{bmatrix}$ is required. This means that the production sectors are unable to cover total costs, so that payments (including tax and wage) arrears are apt to arise, unless massive, unrepayable credits are provided. In particular, apparently deferable expenditures, such as capital maintenance and enhancement and new investment, are apt to be avoided, slowly undercutting the productive capability and future prospects of the economy.

A similar problem arises with the initial price structure once liberalization begins to reveal the true 'costs' of inputs into production. As noted in Section 4, the actual surplus generated from initial 'cost-covering' prices c,

$$c(I-\Lambda) = \begin{bmatrix} .13422 & .094788 \end{bmatrix},$$

is substantially less than that the surplus required to maintain the factors of production (i.e. to purchase the net output y):

$$v = w\ell + rk = \begin{bmatrix} .20833 & .19048 \end{bmatrix}.$$

Further, in initial prices c, that surplus is insufficient to cover even the lower (as properly measured) initial factor costs in the second sector, although an extra surplus is generated in the first sector, when those costs are determined by ν supporting net output z:

$$\nu x \approx cz < cy = vx.^9$$

It is highly unlikely, however, that the unit net value produced, ν, will be sufficient in a liberalized environment as labor begins to demand greater remuneration for its services, and capital begins to command a positive real return. This problem of covering full costs is thus further aggravated by the tendency for wages, and in some cases current capital costs, to rise dramatically, causing even the accurately measured ν to rise substantially to, say, $\widehat{\nu} = \widehat{w}\ell + \widehat{r}k$. Covering these costs requires even higher sectoral prices, raising intermediate input costs further, and perhaps causing final demand, and therefore gross output, to shrink. This is arguably a major source of the financial problems facing unrestructured enterprises at the

[9] At these relative prices, RM earns a profit of $(.13422 - .13333) \times 120 = .1068$ while MG suffers a loss of $(.094788 - .095238) \times 105 = -.04725$. While these numbers are quite small, they do reflect a structural problem that needs to be addressed by altering the relative price structure.

beginning of the transition, and a principle source of the pressure to subsidize industry in order to avoid widespread collapse (deindustrialization).

It is worth illustrating the final point with a numerical elaboration of our simple model. Let $\left\{ \begin{array}{lll} \nu_1 = & .133333 & = w\ell_1 + rk_1 \\ \nu_2 = & .095238 & = w\ell_2 + rk_2 \end{array} \right\}$ where $\left\{ \begin{array}{cc} w = .3 & r = .01 \\ \ell_1 = .411111 & k_1 = 1 \\ \ell_2 = .250796 & k_2 = 2 \end{array} \right\}$, and suppose that the wage doubles while capital costs are totally ignored: $\widehat{w} = .6$, $\widehat{r} = 0$. Then easy calculation gives

$$\widehat{\nu} = \left[\begin{array}{cc} .26666 & .15048 \end{array} \right] \gg c(I - \Lambda) = \left[\begin{array}{cc} .13422 & .094788 \end{array} \right] \approx \nu,$$

implying that there is no way that current costs can be fully covered in the initial price system c or even in p. The problem would only be worse if we were to consider full capital charges in the extreme uncertainty of the early transition, say $r = .2$, yielding a required net surplus (for full cost-coverage) of $\left[\begin{array}{cc} .446667 & .550486 \end{array} \right]$, exceeding even further the net value-added supported by the prices c. This should be compared with the target required net value-added associated with the technology (T, s): $s = \left[\begin{array}{cc} .18 & .15 \end{array} \right]$, where (with some abuse of notation) we set market prices and competitive factor requirement coefficients as $\left\{ \begin{array}{cc} w = .5 & r = .1 \\ \ell_1 = .26 & k_1 = .5 \\ \ell_2 = .2 & k_2 = .5 \end{array} \right\}$.

The equilibrium prices required to support full cost covering with the initial technologies and transition factor prices become

$$\widehat{p} = \widehat{\nu}(I - \Lambda)^{-1} = \left[\begin{array}{cc} 1.7558 & 1.8991 \end{array} \right] \gg p$$

or even P. In the absence of changes in the structure of production/technology, these prices would propagate through the economy as each producer raises his prices to cover both higher factor costs (given by the technology) and increased input prices from others doing the same thing. This gives a sequence of increasing prices that is, on average, approximated by the series

$$\widehat{p}_t = \sum_{n=0}^{t} \widehat{\nu}\Lambda^n \underset{n \to \infty}{\uparrow} \widehat{p}.$$

Were the world perfectly linear, and final demand independent of price (the ideal world for central planning), then this process would yield a price system that covered costs and supported the current technology for the provision of required final outputs.

In reality, however, these prices create resistance in both final demand and intermediate demand, even if the latter is largely due to financing difficulties. Both less valuable uses and less efficient (than the sectoral average) producers are driven away, and the inability to cover full costs leads to a drop in investment in, and even maintenance of, the capital stock. While the shutdown of the less efficient and the shrinkage of old capacities begins a technological restructuring, major technological restructuring calls for increased rather than decreased investment, and that is undercut by the inability of many, if not most, sectors to recover full costs of production. Further, the price adjustment process is apt to be cut short by competition from outside, and from those firms that do succeed in adopting new, more efficient technologies, perhaps supportable by the price system P. This seals the fate of the old technological structure, insuring that market prices will never be sufficiently high to cover its full costs.

Thus substantial structural change, altering the technologies in use, must eventually take place. How that might happen, and the paths the restructuring process might take, requires a more detailed dynamic microeconomic analysis which goes far beyond the static input-output tools used here. All that this static analysis can do is highlight some of the pressures that will condition the transition process and indeed make embarking on it a necessity.

6. Conclusion.

The point made by these examples is quite simple: the input-output tables of the centrally planned economies, and in particular of the Soviet Union, systematically concealed an extremely inefficient structure of technology and production, one which is unable to reproduce itself (cover the full costs of production) at market generated prices. What we show here is the **possibility**; we do not provide a proof that that was actually the case — we only argue its plausibility. Indeed, accepting this argument seems to cast light on the (initially) largely unexpected difficulty of the ongoing transition from 'command' to 'market.'[10]

The existence and wasteful nature of the command economy technological structure is arguably one of the determining, yet under appreciated, characteristics of the difficult transition that we are observing. Liberalization in the face of this legacy reveals the extraordinary costs of transition and difficulties of financing restructuring, and creates strong incentives to soften the blow of liberalization by

[10]See the discussion in Blanchard, et. al., (1994), especially the editors' Introduction and the first chapter by Michael Bruno, for a survey of the more traditional explanations.

subsidizing and supporting, through special privileges and licensing, the existing production units and their technological structures. Such incentives are illustrated in our example. Indeed, the existing structure rationalizes 'price-regulation' to control costs, thereby maintaining a net-value surplus that could be invested in restructuring. But doing so undercuts the possibility of successful restructuring in at least two ways: it destroys both information and incentives for proper restructuring; and it allows current claimants to continue to control real resource flows, tying those resources to traditional uses and thus undercutting structural reform of the economy. That, however, is a discussion beyond the limits of this note.

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